

URL Filtering using SNI for HTTPS websites

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Check Point URL Filtering

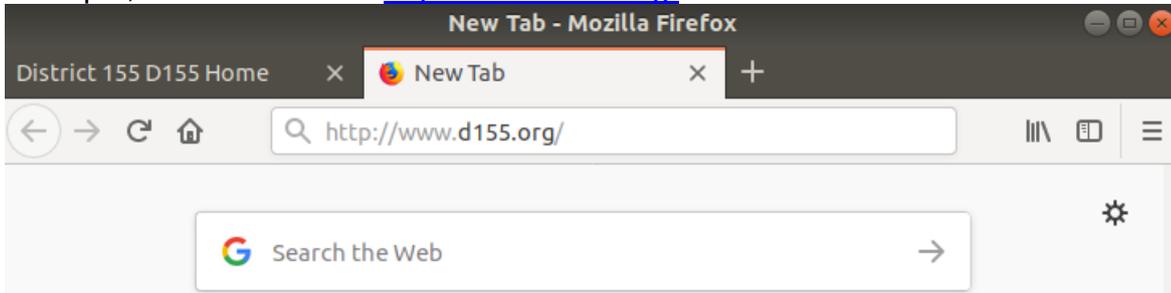
Check Point has included web filtering with its security gateways for many years. URL Filtering is a standard blade included with all Next Generation Threat Prevention (NGTP) and Next Generation Threat Extraction (NGTX) packages. As is common with most major web filtering vendors, Check Point tracks over 200 million websites and categorizes them into 70+ categories for easy identification and policy configuration. These categories are typically used in the Access Control policy to Block and/or Allow websites by their category tags, with specific sites being identified by the creation of Custom Site to allow for policy exceptions to the general category, or for categorization override. An example URLF policy for Check Point R80.10 is shown here:

No.	Name	Source	Destination	Services & Applications	Content	Action	Track
5	Access to Internet according to Web control policy	InternalZone	Internet	* Any	* Any	Web Control	N/A
5.1	Block abuse/ high risk applications	Corporate LANs Branch Office LAN	Internet	Child Abuse Gambling High Risk Pornography Spyware / Malicious Sites	* Any	Drop Blocked Message ...	Log
5.2	HR can access to social network applications	HR	Internet	Social Networking	* Any	Inform Access Approval Once a day Per application/site	Log Accounting
5.3	All employees can access YouTube for work purposes	Corporate LANs Branch Office LAN	Internet	YouTube - Custom Site	* Any	Ask Company Policy Once a day Per application/site	Log
5.4	Block specific URLs	* Any	Internet	Blocked URLs	* Any	Drop	Log
5.5	Block specific categories for all employees	Corporate LANs Branch Office LAN	Internet	Social Networking Streaming Media Protocols P2P File Sharing	* Any	Drop Blocked Message ...	Log
5.6	Cleanup	* Any	* Any	* Any	* Any	Accept	Log

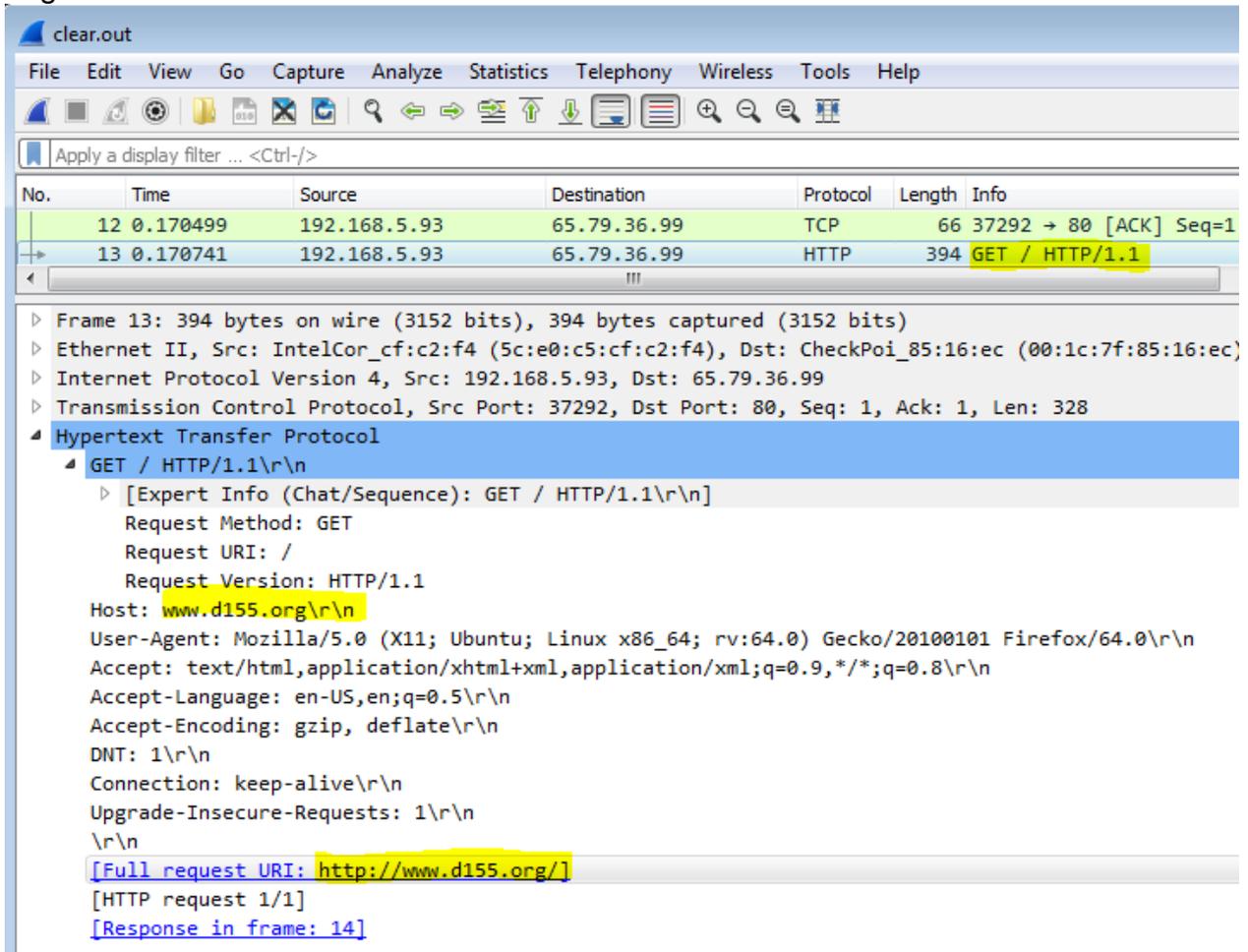
The process of maintaining these website categorizations, querying the cloud database for current categories and locally enforcing web filtering policies based on these categories is necessarily a complex procedure with many options. For our purposes, however, we can assume that this is all magic and works perfectly in all circumstances. Still, in order for URL filtering to work accurately in real time, the security gateway must have a way to discover the website that is being accessed in the first place. As it turns out, this is not always easy.

URL Filtering for HTTP

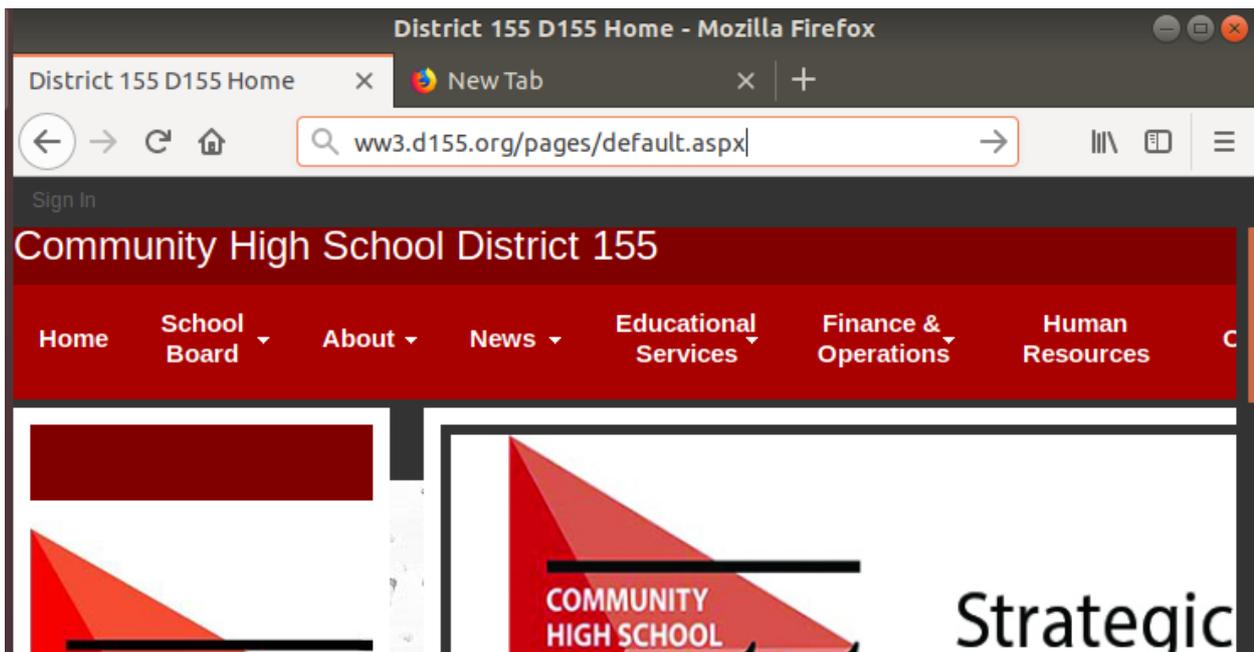
For clear-text web connections using HTTP on standard port 80, the gateway only needs to read and categorize the site requested by the client via HTTP GET command. For example, I used Firefox to <http://www.d155.org/> for our local school district website.



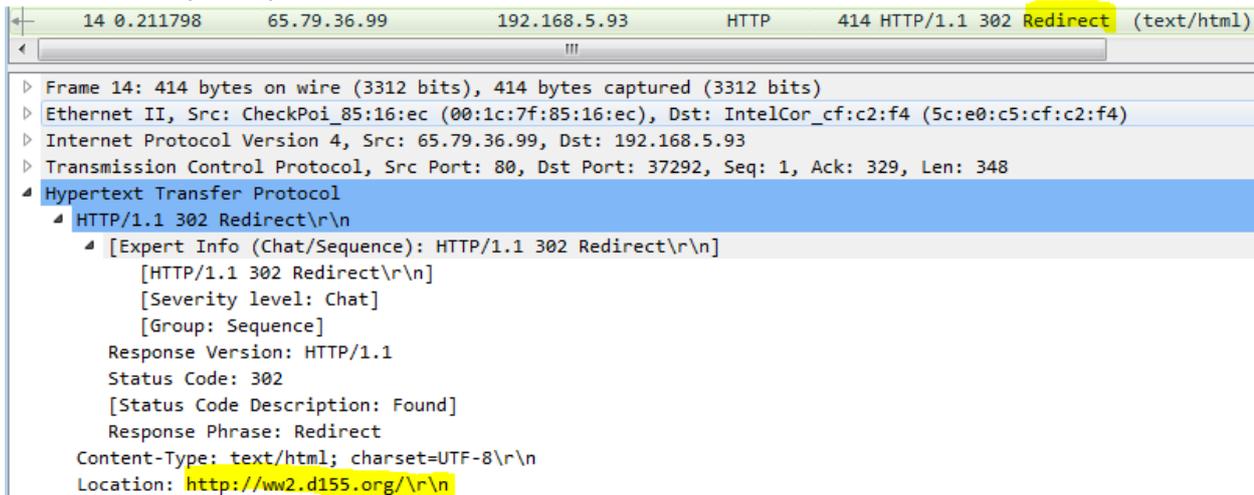
Via tcpdump/wireshark, we can see that request as it traverses the gateway with the original GET command:



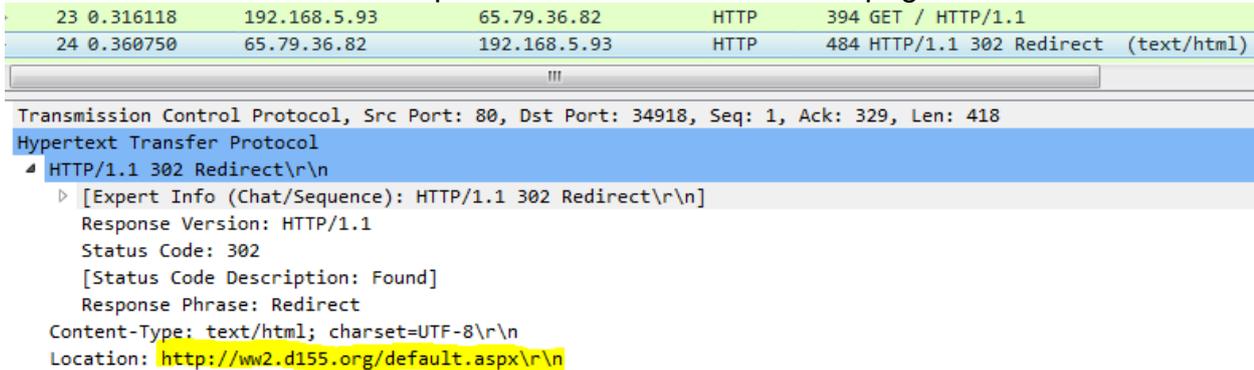
As it happens, website request is successfully redirected to another related site which the browser then loads:



Since this is also a clear-text HTTP website, we can see that client / server communication as well via tcpdump / wireshark:



This recursively prompts another client GET for the new location, which is redirected one more time before the client requests the current site and the page is loaded:



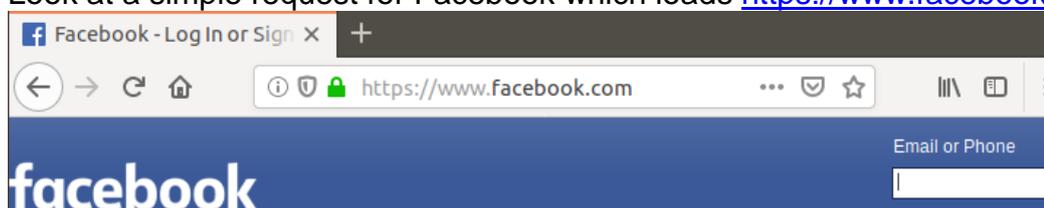
The point here is that the requested website and all the client/server communication is clear-text and thus readable by the security gateway. It can parse the requested website

and lookup the associated category of the site, and thus enforce the configured web filtering policy.

URL Filtering for HTTPS

But, this method of URL capture and categorize is not possible on the large and growing number of websites that use HTTPS to encrypt the HTTP client/server communication. There are a number of sites that may respond to an HTTP client request simply to re-direct the client to an HTTPS-enabled website, and a number of others that will only communicate using HTTPS. Because the HTTP communication is encrypted, the gateway (or any other device in the middle) is unable to read the GET/POST, etc. of the HTTP messages. So how does the gateway determine the URL of the requested website in order to block or allow the connection based on the URL's categorization?

Look at a simple request for Facebook which loads <https://www.facebook.com>:



The associated tcpdump/wireshark analysis of packet flow does not show any HTTP requests:

46	10.961730	192.168.5.93	8.8.8.8	DNS	87 Standard query 0xebc7 A www.facebook.com OPT
47	10.970006	192.168.5.93	8.8.8.8	DNS	87 Standard query 0xc8f0 AAAA www.facebook.com OPT
48	10.995611	8.8.8.8	192.168.5.93	DNS	144 Standard query response 0xc8f0 AAAA www.facebook.com CNAME s
49	11.022327	8.8.8.8	192.168.5.93	DNS	132 Standard query response 0xebc7 A www.facebook.com CNAME star
50	11.025890	192.168.5.93	157.240.2.35	TCP	74 48284 → 443 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1
51	11.049784	157.240.2.35	192.168.5.93	TCP	74 443 → 48284 [SYN, ACK] Seq=0 Ack=1 Win=27960 Len=0 MSS=1410
52	11.054300	192.168.5.93	157.240.2.35	TCP	66 48284 → 443 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=92094382
53	11.055685	192.168.5.93	157.240.2.35	TLSv1.3	583 Client Hello
54	11.080896	157.240.2.35	192.168.5.93	TCP	66 443 → 48284 [ACK] Seq=1 Ack=518 Win=29184 Len=0 TSval=193862
55	11.082945	157.240.2.35	192.168.5.93	TLSv1.3	1464 Server Hello, Change Cipher Spec, Application Data
56	11.083130	157.240.2.35	192.168.5.93	TLSv1.3	1464 Application Data [TCP segment of a reassembled PDU]
57	11.083207	157.240.2.35	192.168.5.93	TLSv1.3	539 Application Data
58	11.084257	192.168.5.93	157.240.2.35	TCP	66 48284 → 443 [ACK] Seq=518 Ack=1399 Win=32128 Len=0 TSval=920
59	11.084614	192.168.5.93	157.240.2.35	TCP	66 48284 → 443 [ACK] Seq=518 Ack=3270 Win=35840 Len=0 TSval=920
60	11.091968	192.168.5.93	8.8.8.8	DNS	88 Standard query 0xb32a A ocp.digicert.com OPT
61	11.117128	8.8.8.8	192.168.5.93	DNS	136 Standard query response 0xb32a A ocp.digicert.com CNAME cs9

```

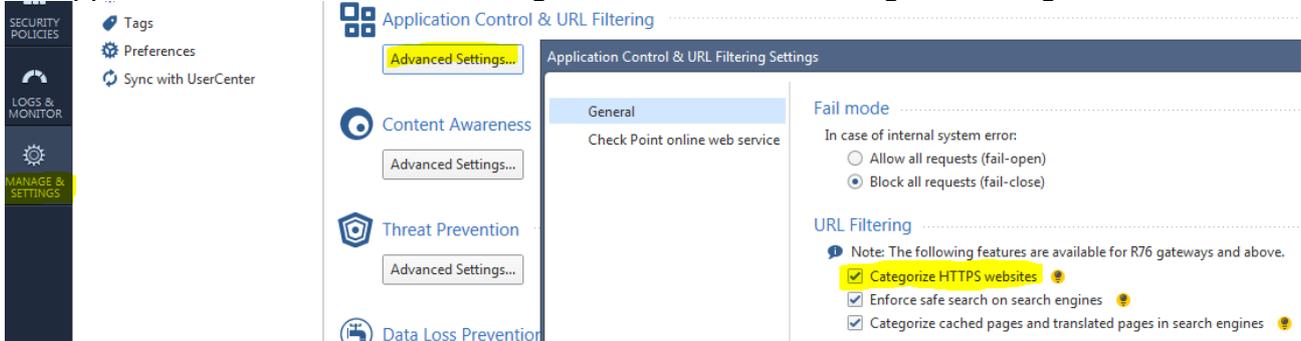
> Frame 53: 583 bytes on wire (4664 bits), 583 bytes captured (4664 bits)
> Ethernet II, Src: IntelCor_cf:c2:f4 (Sc:e0:c5:cf:c2:f4), Dst: CheckPoi_85:16:ec (00:1c:7f:85:16:ec)
> Internet Protocol Version 4, Src: 192.168.5.93, Dst: 157.240.2.35
> Transmission Control Protocol, Src Port: 48284, Dst Port: 443, Seq: 1, Ack: 1, Len: 517
  Secure Sockets Layer
    TLSv1.3 Record Layer: Handshake Protocol: Client Hello
      Content Type: Handshake (22)
      Version: TLS 1.0 (0x0301)
      Length: 512
    Handshake Protocol: Client Hello
      Handshake Type: Client Hello (1)
  
```

Note that we only see the DNS request for www.facebook.com, then TCP handshake, and then TLSv1.3 using SSL. The DNS request, although clear-text, is not a reliable guide to the subsequent HTTPS connection.

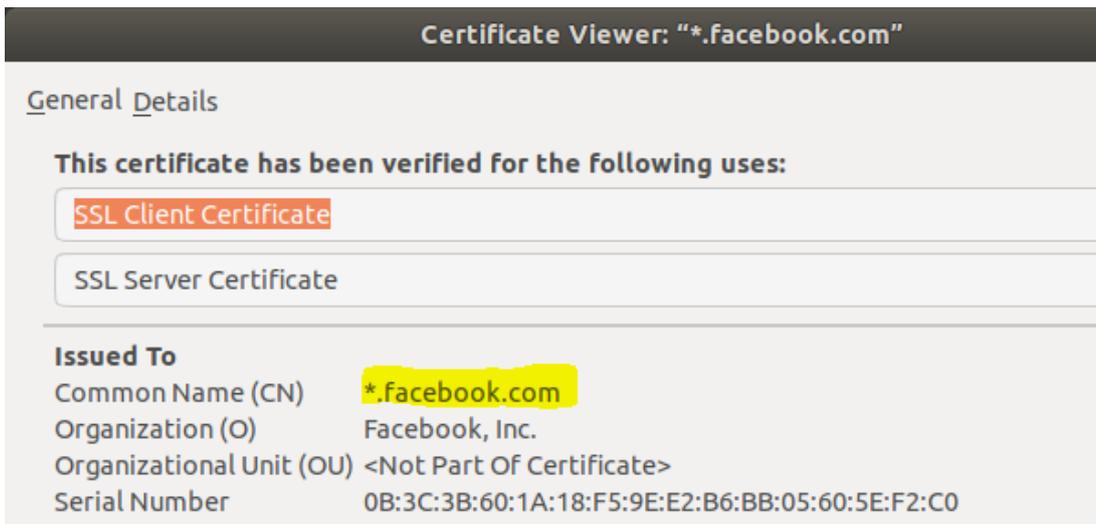
Many organizations have opted to use full HTTPS inspection, inserting their edge security gateways into the middle of this transaction in order to decrypt and then re-encrypt the connection. This route involves practical, performance and security obstacles, and is not a workable solution in all environments. So what other option is there to reliably filter HTTPS web traffic?

Categorize HTTPS Websites via Certificate Checking

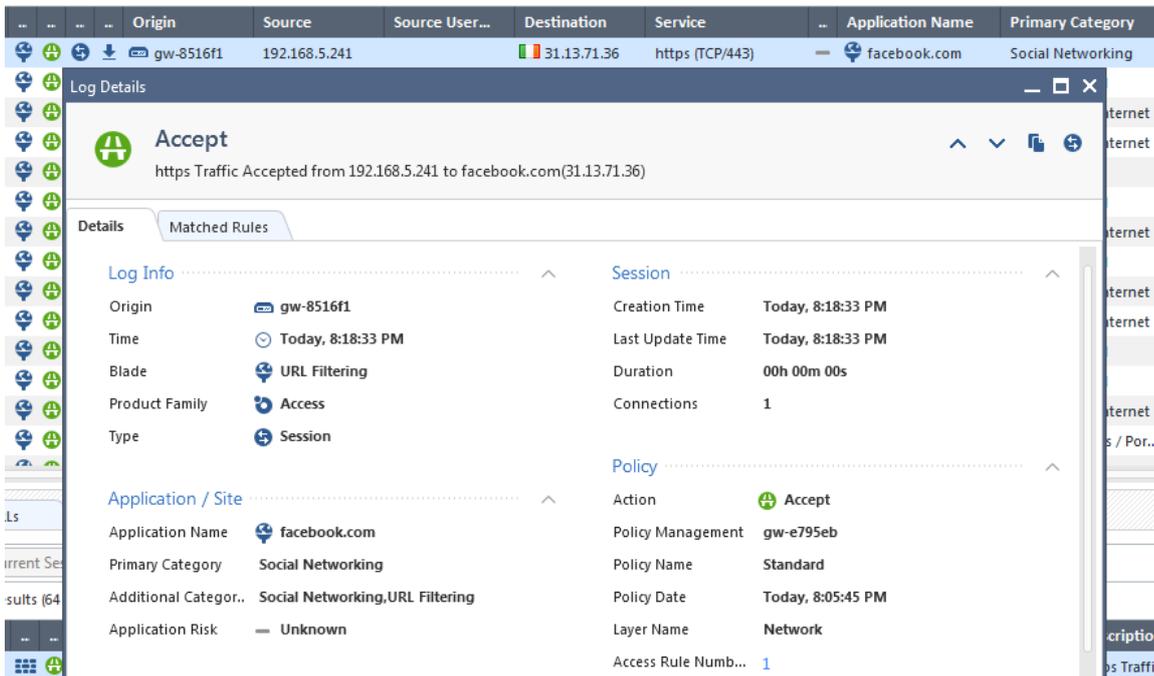
Check Point offers a feature called “Categorize HTTPS websites” in the advanced settings for Application Control & URL Filtering found under the “Manage & Settings” tab in R80.x:



How is this accomplished? Obviously, the gateway must be able to read the URL in the part of the client/server communication that is clear-text. So let’s take another look at the Facebook connection. Although the HTTP communication is SSL encrypted, the associated certificate is transferred in clear-text and can be read by the gateway. And the cert presumably will identify the website via Common Name (CN). In the case of Facebook, the CN is listed as *.facebook.com



This is how a Check Point gateway can determine the website being accessed, look up the category and enforce the filtering policy. The log for this traffic reflects the correct category:



Problems with HTTPS Categorization via Certificate Checking

That is a relatively simple solution, but it doesn't work in all cases. Looking at the details in the site certificate:



Looking deeper, the certificate includes a field for Subject Alternative Name. For this certificate, there are a number of other DNS names listed including one for [*.messenger.com](https://www.messenger.com).

Certificate Viewer: "*.facebook.com"

General Details

Certificate Hierarchy

- ▼ DigiCert High Assurance EV Root CA
 - ▼ DigiCert SHA2 High Assurance Server CA
 - *.facebook.com

Certificate Fields

- Subject's Public Key
- ▼ Extensions
 - Certificate Authority Key Identifier
 - Certificate Subject Key ID
 - Certificate Subject Alt Name**
 - Certificate Key Usage
 - Extended Key Usage

Field Value

- DNS Name: *.facebook.net
- DNS Name: *.xy.fbcdn.net
- DNS Name: ***.messenger.com**
- DNS Name: fb.com
- DNS Name: *.fbcdn.net
- DNS Name: *.fb.com

What happens if we try to access <https://www.messenger.com>? We will get the exact same certificate:

Page Info - https://www.messenger.com/



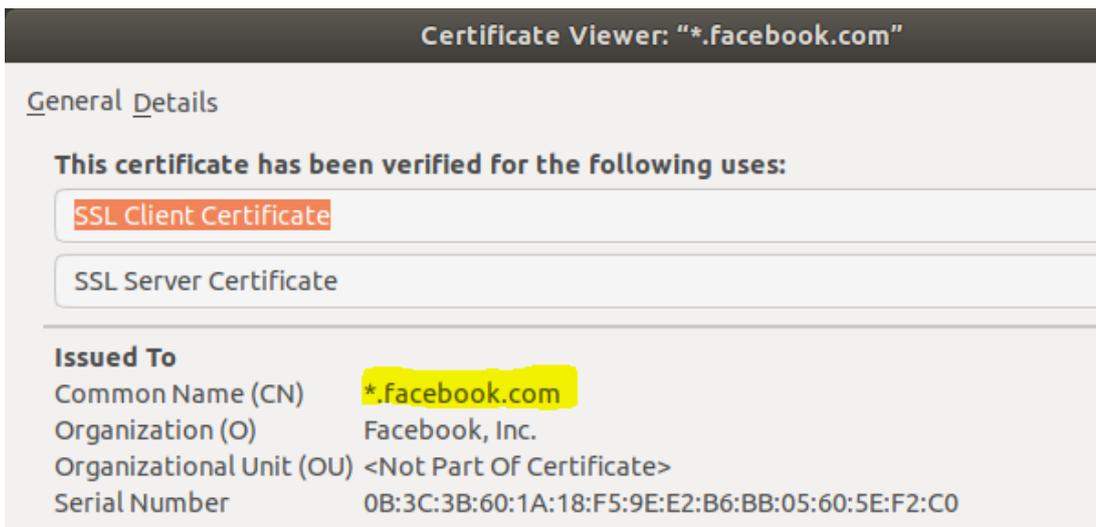



General Media Permissions **Security**

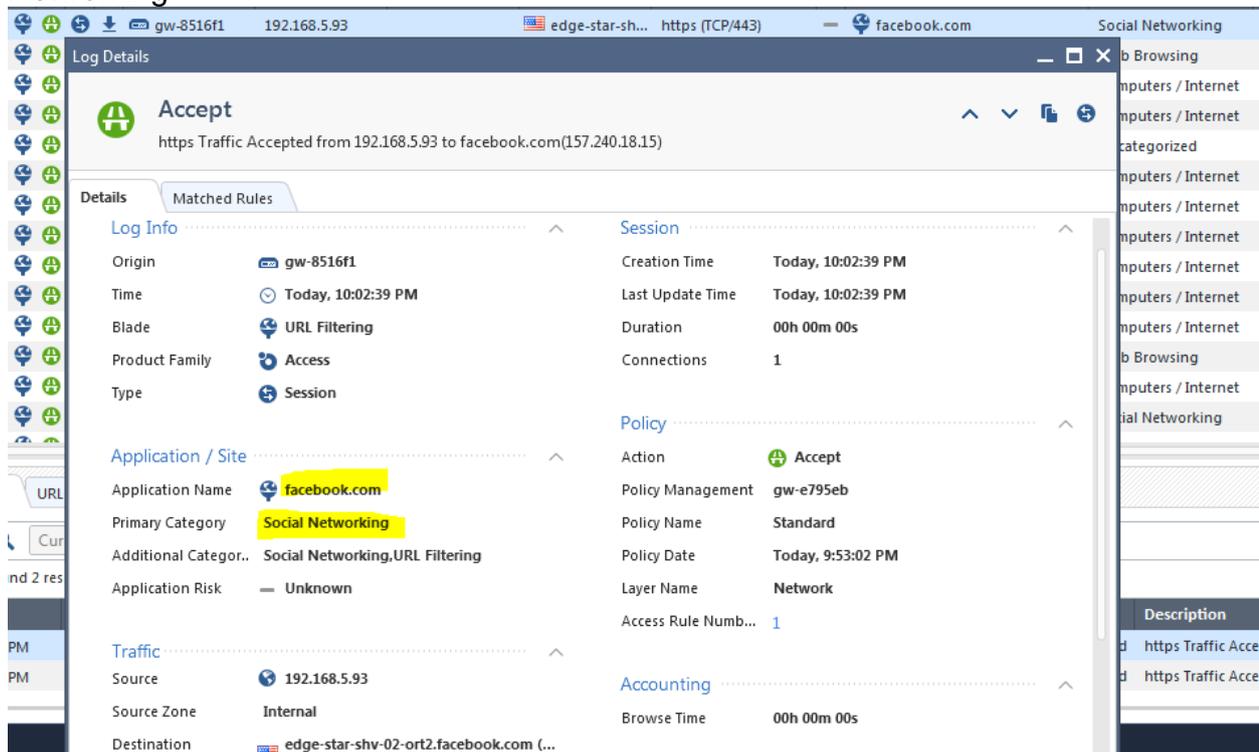
Website Identity

Website: **www.messenger.com**
 Owner: **This website does not supply ownership information.**
 Verified by: **DigiCert Inc**
 Expires on: **March 22, 2019**

And given the HTTPS categorization according to CN of the certificate, the site will be blocked or allowed as though this is a connection to Facebook.



And the associated URLF log shows this Accept based on Facebook category of Social Networking:



That might seem OK, because these are related sites as Messenger was developed by Facebook. But by itself, Messenger is not properly categorized as Social Networking, but as Instant Chat or Instant Messaging:

URL Categorization

For <http://www.messenger.com>
Categories: Instant Chat, Instant Messaging

If the URL policy accepts Social Networking, but blocks Instant Messaging, www.messenger.com will be incorrectly categorized and allowed. To correctly categorize

the site, a custom site specifically created in order to block Messenger would be required. And this is just one case of many similar websites that share a certificate with sites that belong in different categories.

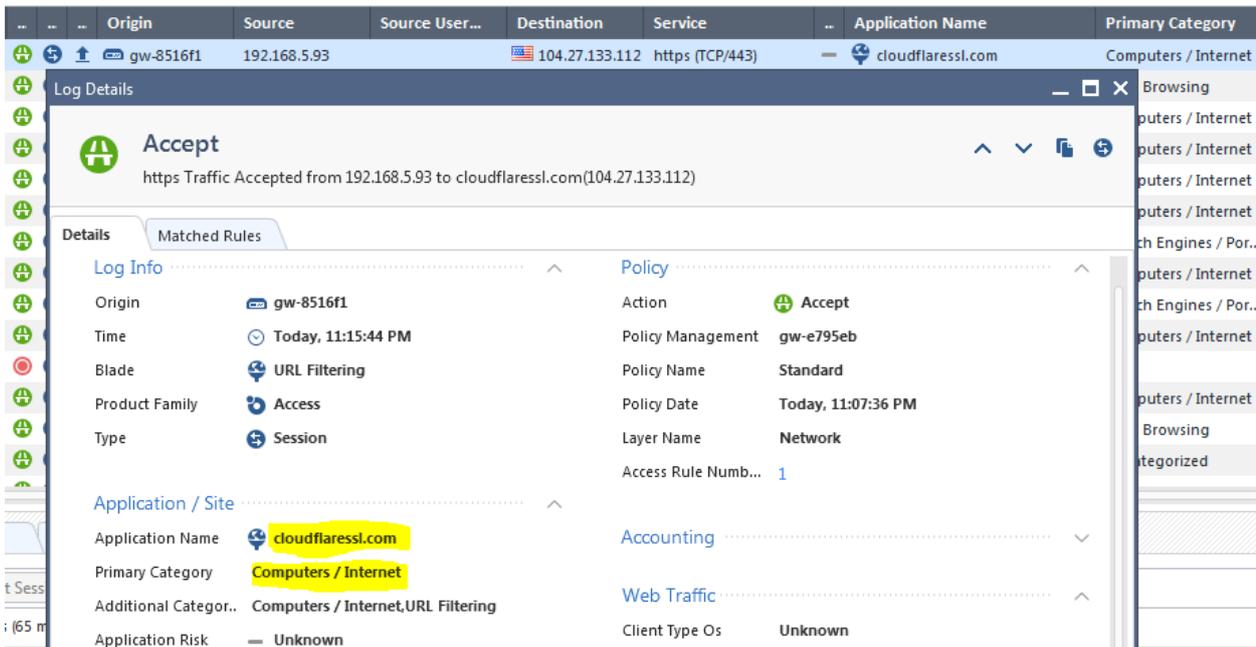
For a more extreme case, consider the following scenario. A corporate URL filtering policy very commonly blocks sites categorized as Sex or Pornography. One such site is



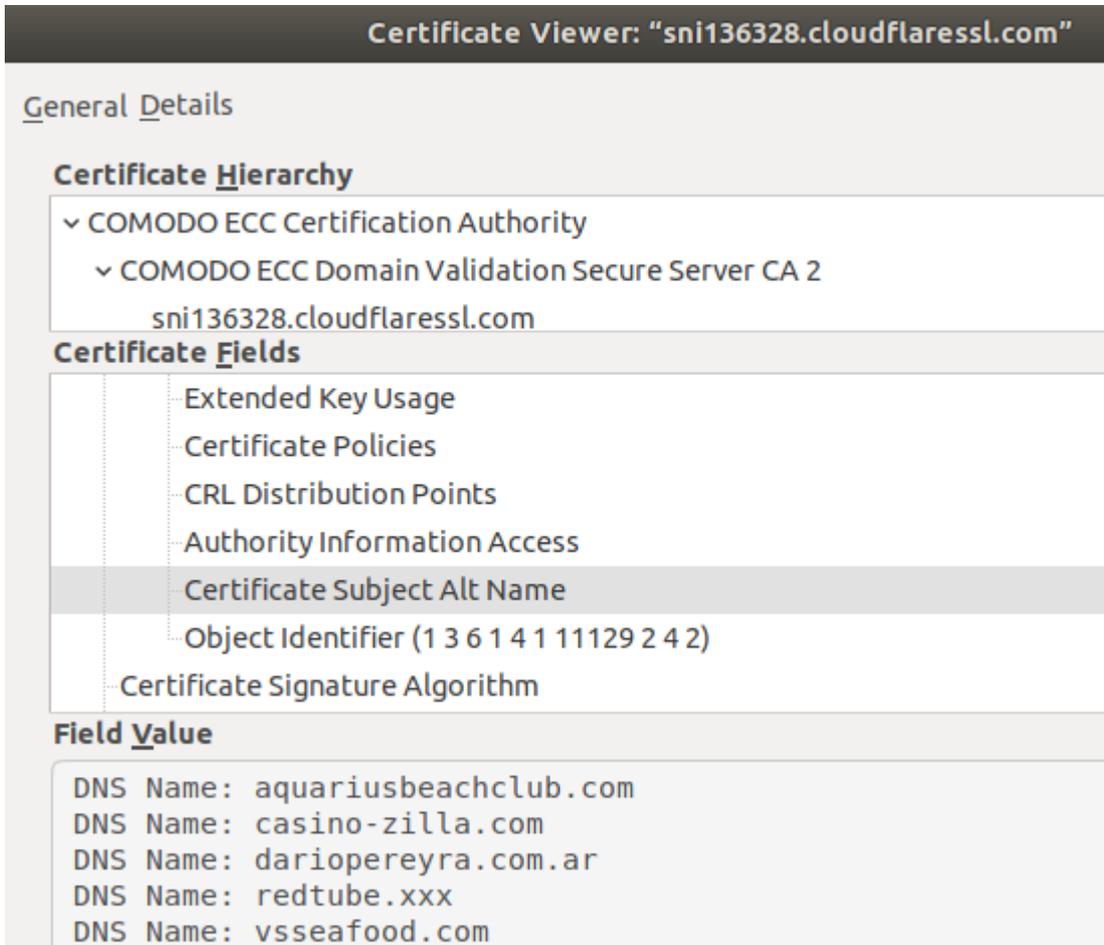
But with a Block on Pornography, why is that website allowed? It's HTTPS, so we can look at the certificate, and we find that the CN is "sni136328.cloudflaressl.com".



And that URL is categorized as "Computers / Internet", so we see that the traffic is allowed based on that information when we look at the associated log.



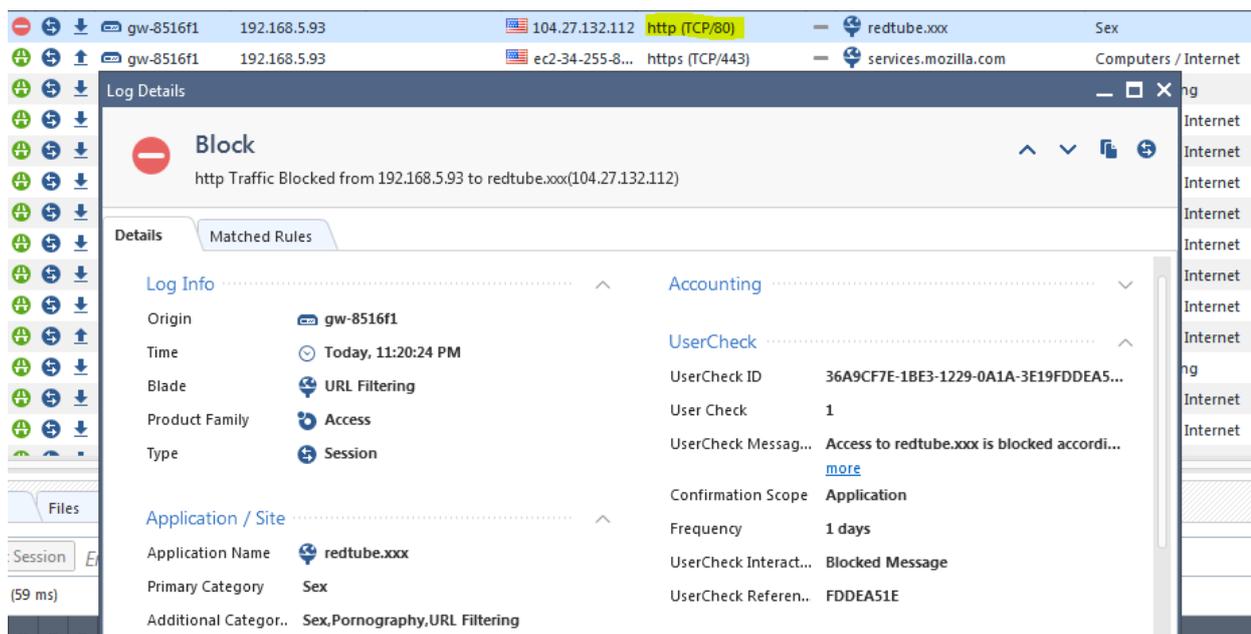
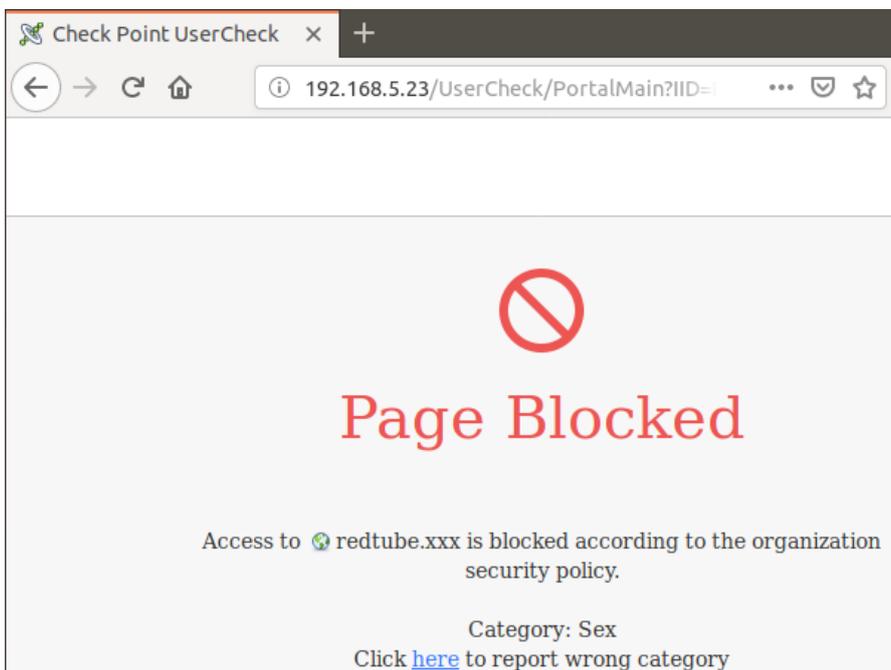
Why is “redtube.xxx” using a certificate from “sni136328.cloudflaressl.com”? And should the browser at least give a warning to the user that this site is not the same as listed in the certificate? If we look deeper at the certificate details, we find multiple DNS names listed as they all share the same certificate from cloudflare.



These sites are very different, but all using the same certificate as the basis for categorization. But each of these DNS name should be categorized differently according to Check Point's URL lookup site <https://urlcat.checkpoint.com/urlcat/main.htm>

- casino-zilla.com – Gambling
- aquariusbeachclub.com – Travel
- dariopereyra.com.ar – General
- vsseafood.com – Restaurants / Dining / Food

Moreover, <http://www.redtube.xxx> itself is categorized as a Sex site when using HTTP rather than HTTPS.



So the use of the CN listed in the certificate is not a reliable guide when the Subject Alternative Name (SAN) field is used to cover multiple different sites. And trying to use the SAN entries to make a category choice will lead to contradictory results. We need to discover which of those sites the client is trying to access. Also, this information must be found in clear-text portion of the client/server communication.

Categorize HTTPS Websites via SNI

Looking again at the tcpdump / wireshark analysis of the traffic, the very first Client Hello using SSL shows the server that the client is specifically requesting, under the Server Name Indication (SNI) extension.

76	11.841851	192.168.5.93	104.27.133.112	TCP	60	36884 → 443 [ACK] Seq=1 Ack=1 Win=29312 Len=0
77	11.842576	192.168.5.93	104.27.133.112	TLSv1	571	Client Hello

```

▶ Ethernet II, Src: IntelCor_cf:c2:f4 (5c:e0:c5:cf:c2:f4), Dst: CheckPoi_85:16:ec (00:1c:7f:85:16:ec)
▶ Internet Protocol Version 4, Src: 192.168.5.93, Dst: 104.27.133.112
▶ Transmission Control Protocol, Src Port: 36882, Dst Port: 443, Seq: 1, Ack: 1, Len: 517
└─ Secure Sockets Layer
  └─ TLSv1 Record Layer: Handshake Protocol: Client Hello
    Content Type: Handshake (22)
    Version: TLS 1.0 (0x0301)
    Length: 512
  └─ Handshake Protocol: Client Hello
    Handshake Type: Client Hello (1)
    Length: 508
    Version: TLS 1.2 (0x0303)
    ▶ Random: e5b605a0ae0ea12122dd061e4e6200777ca33b1824943911...
    Session ID Length: 32
    Session ID: 3ff5fa9a4856f7183a171d3b89eb62de81bcd4f88cc5d6...
    Cipher Suites Length: 36
    ▶ Cipher Suites (18 suites)
    Compression Methods Length: 1
    ▶ Compression Methods (1 method)
    Extensions Length: 399
  └─ Extension: server_name (len=20)
    Type: server_name (0)
    Length: 20
  └─ Server Name Indication extension
    Server Name list length: 18
    Server Name Type: host_name (0)
    Server Name length: 15
    Server Name: www.redtube.xxx
  
```

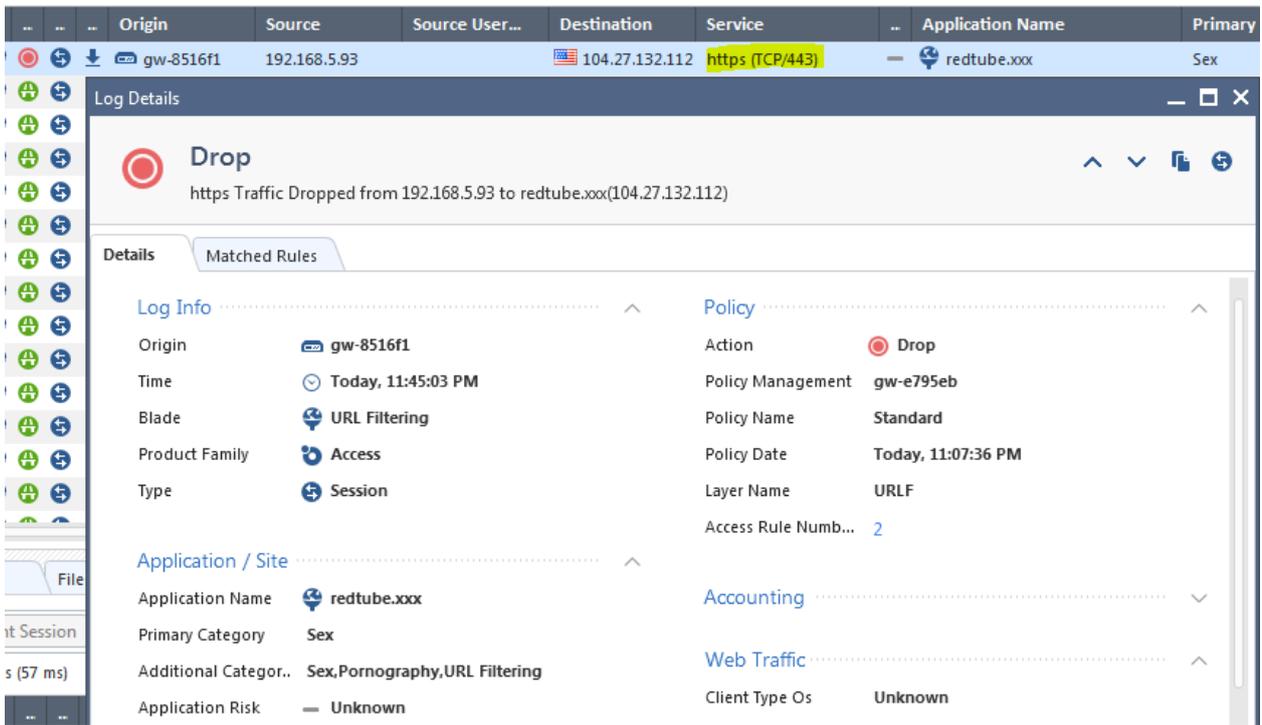
Using this field, rather than relying on the CN of the certificate, gives more specific and accurate information about the requested site. The recently released hotfix for Check Point R80.10 gateways does change this behavior and utilize the SNI extension for categorization. Once installed, the feature can be enabled with the following command:

```
fw ctl set int urlf_use_sni_for_categorization 1
```

This hotfix also allows a further check to make sure that the SNI requested by the client matches one of the SAN entries on the certificate. To enable this feature, use this command:

```
fw ctl set int urlf_block_unauthorized_sni 1
```

With it, we can now see that this site, despite the shared certificate and HTTPS encryption, is properly categorized and blocked in the gateway logs.



This feature is available now for R80.10 gateways with Take 154 via Solution Center, and planned to be rolled into Jumbo Hotfix release for both R80.10 and R80.20 in the near future.